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Scientific Manpower Resources of the USSR  
before Council of Foreign Relations, New York, March 29, 1956,  
by [REDACTED], Central Intelligence Agency

As you all know, the scientific-technical manpower shortage is a matter of real concern in this country. Perusal of "want ad" pages from any Sunday New York Times serves to emphasize, if indeed emphasis is needed, the extent to which American industry is crying for engineers and physicists. United States industries, long experienced in competitive free enterprise, now are directing much of this competitive skill toward luring engineers and scientists to their companies. The race is on! For future business achievements will go to the firms which are successful in recruiting competent technical manpower now.

The race is on not only among United States companies, however, but between nations. The United States and the Soviet Union are each trying to outstrip the other in producing large numbers of scientists and technicians. In the Soviet Union impetus is given the program from highest government authorities. Out of the 67 members of the USSR Council of Ministers, 39 have had a scientific or technical education. Significantly, 9 of the 13 First Deputy and Deputy Chairmen have technical backgrounds. These men know the importance of technical training and are in a position to give assistance when and where it is needed.

Today the United States and the Soviet Union each has a scientific-technical manpower force of about 1.2 million. In research and teaching the Soviet Union has a force only about 2/3ds that of the United States (175,000 vs 265,000). In research alone, they have only about half the number we have (120,000 vs about 210,000). But each year, though we turn out 10% more college graduates than they, they graduate many more in science and engineering than we do. For example, in 1955, 50% of Soviet full-time students graduated in scientific-technical fields as compared to only about 25% in the United States. In engineering alone, the Soviet Union graduated twice as many as did the United States.

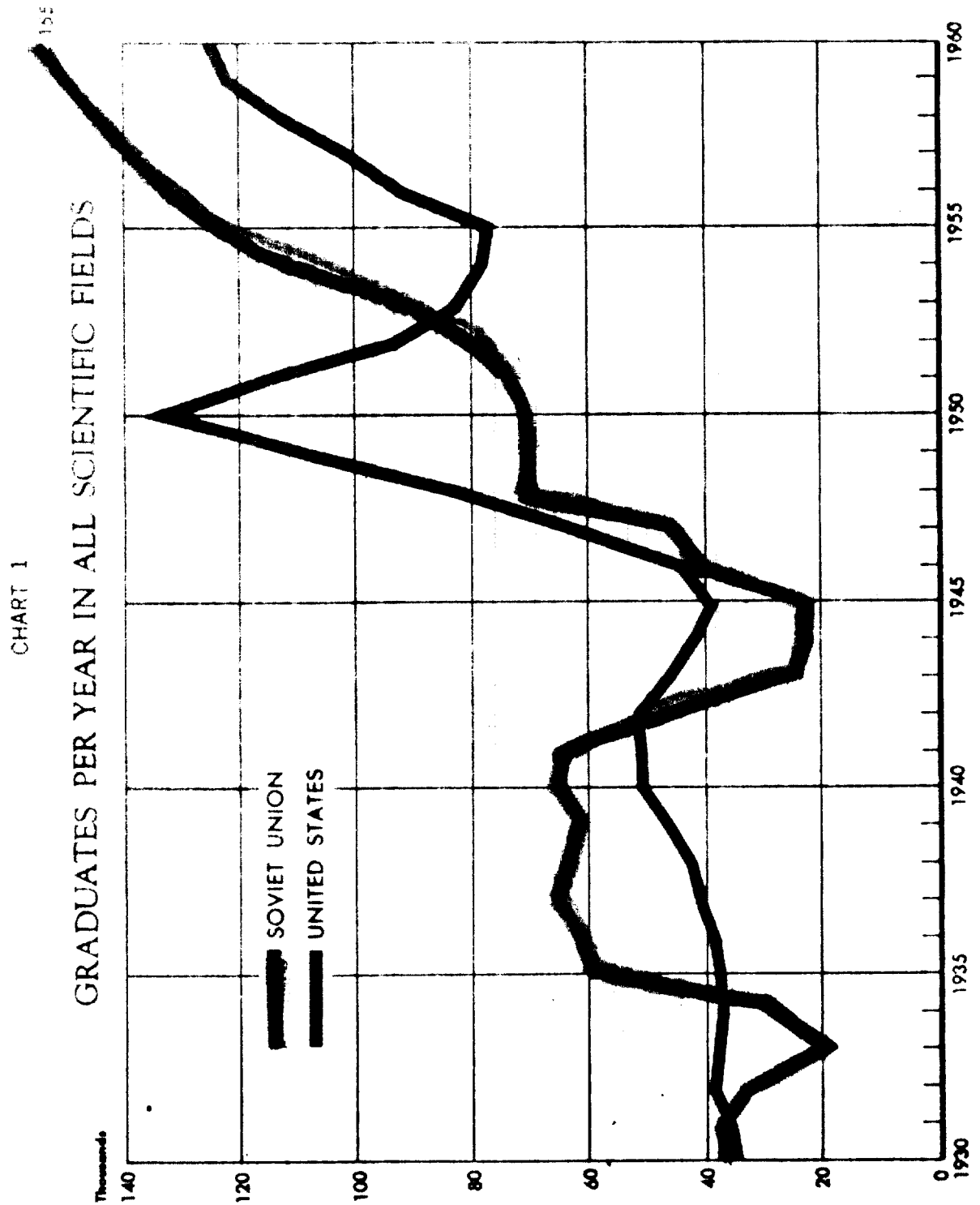
Chart 1, Graduates per Year in All Scientific Fields, shows the steady increase in both countries in numbers of graduates in all science fields from 1930 to 1960. In 1930 both countries were almost equal, each graduating about 36,000 science students. The 1933 drop to 19,000 in the Soviet curve resulted from a lengthening of courses. The rise in 1935 (in the Soviet curve) reflects the expanded enrollments in 1930/32. Both the United States and Soviet curves show wartime losses from about 1942/43 to 1945. Soviet losses were greater than ours. They dropped to about 22,000 in 1945 compared to about 39,000 in the United States. Rapid post-war increases are shown for both countries. We climbed

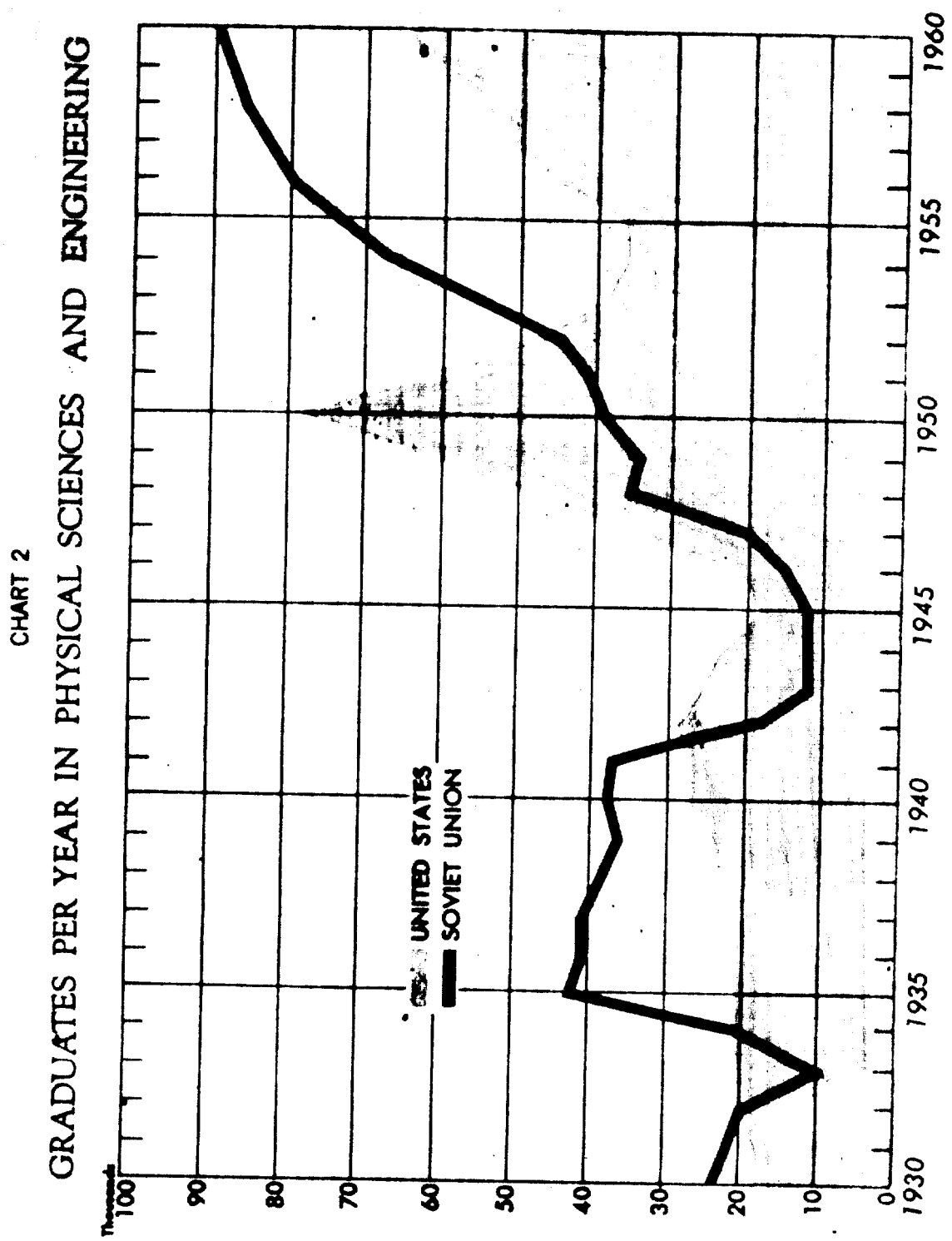
faster and farther and reached a peak of about 134,000 science graduates in 1950, largely under the "GI Bill", and then started declining. They climbed less spectacularly, but note that the Soviet curve did not go into a decline. That curve is still rising. In June 1954 Soviet science graduates outnumbered ours by about 36,000. It is estimated that in 1960 the Soviet Union will graduate about 155,000 science students compared to about 126,000 in the United States.

Chart 2, Graduates per Year in Physical Sciences and Engineering, shows a comparison of American and Soviet graduates in the physical sciences and engineering only for the period 1930 to 1960. During the early 1930's, the United States graduated more engineers and physical scientists than did the Soviet Union. In 1935 and 1940, as a result of planned expanded enrollments in 1930 to 1932, the Soviets graduated more than did the United States. Wartime losses are shown. Again, the Soviets dropped lower than did the United States. Post-war expansions are obvious. Note that in 1950 we graduated almost twice as many in the physical sciences and engineering as they did. But by 1953 a reverse trend was developing and in June 1954 the Soviets graduated 57% more than we did: about 65,000 in the USSR compared to about 38,000 in the United States. It is estimated that the Soviets will graduate 90,000 in the physical sciences and engineering in 1960 compared to about 65,000 in the United States.

If these trends continue, it is apparent that soon the Soviets will have a decided advantage in numbers of scientific-technical personnel. Continued expansion of their manpower reservoir is assumed by the Soviet educational system. Because the educational system is a key factor in this race, I should like to point up some of its more important features. First of all, the system is designed mainly to train scientists, technicians, and skilled labor for the nation's economy. Even elementary schools stress science. There are no electives; therefore every Soviet student has taken 5 years of physics, 5 years of biology, 4 years of chemistry, 10 years of mathematics, and a year of astronomy by the time he finishes high school. Compared with American high school graduates, less than 10% of whom have taken as much as a year of physics and chemistry, and even fewer any advanced mathematics, the Soviet high school graduate has a much better science foundation. An evaluation of Soviet high school textbooks for physics courses shows that the books' coverage is not so up-to-date as that presented in United States high school texts, but the range of materials presented is broader.

After completing high school, the better students enter a higher educational institution. Honor students are admitted without taking entrance examinations, but all others must pass stiff comprehensive exams in Russian language and literature, mathematics, physics,





chemistry, and one foreign language. All entrance examinations are oral, except Russian which is written and mathematics which is both written and oral. Future Soviet engineers and scientists are trained at one of 3 types of higher educational institutions:

- (a) Engineering and technical colleges offer 4-5 year courses in specialized fields such as machine building, construction, and agricultural mechanization. These colleges prepare engineers and specialists for particular industries.
- (b) Polytechnic institutes offer 4-6 year courses in broader engineering fields such as civil, electrical, and metallurgical engineering. Students graduate as production engineers and enter the economy.
- (c) Universities offer 5-5½ year courses in fundamental sciences. Graduates enter research or teaching-- the better graduates are directed to research.

Almost half a million students enter these Soviet colleges each year. They spend, as indicated, 4-6 years in a rigorous course of study. Discipline is strict. Attendance at lecture and laboratory sessions is compulsory. As many as 10 comprehensive examinations are given each year. Those who fail are weeded out. Those who do well are rewarded by increased stipends.

While in college students spend as much as 90% of their time on technical subjects. The next four charts show translations of curriculum requirements listing subjects of instruction and the number of hours allotted for lectures, laboratory work, and practical study for each subject. The first two charts (3 and 3a) show the 1955 curriculum prescribed for physics majors at Kharkev State University. Chart 3 lists the scientific subjects studied and the number of hours spent on each subject. Students spend 3,556 hours out of a total of 4,290 hours over a 4½ year period studying scientific subjects. Chart 3a lists curriculum requirements in non-scientific subjects. Only 724 hours are spent on non-scientific subjects. The pie diagram shows graphically that 83% of the student's time is spent on scientific-technical subjects.

Charts 4 and 4a, prescribe the curriculum for mechanical engineering students majoring in "Machine Construction, Metal Cutting Machine Tools, and Tools" at Bauman Higher Technical School in Moscow. (Bauman, incidentally, is the best technical school in the country. It is superior to any technical school in the U.S. and compares favorably with MIT in this country. One of the impressive facts

about Bauman is that all of its engineering students take physics courses which correspond in level to those taken by physics majors in this country and which are rarely taken by engineering students here. Every Bauman graduate has a training in physics corresponding to a stiff physics undergraduate minor in the United States.) Chart 4 lists scientific subjects. Out of a total of 4,848 hours spent on instruction, laboratory work, and practical study 4,322 are devoted to scientific subjects. Chart 4a shows the non-scientific subjects prescribed. Only 526 hours are spent on non-scientific subjects. The pie diagram shows that 89% of the Bauman student's time is devoted to scientific-technical subjects. For purposes of comparison, at MIT the curriculum prescribed for mechanical engineering students specializing in materials and material processing includes 2,895 hours of instruction and laboratory work. 2,265 hours or 78% of the student's time is spent on scientific subjects.

Quality of training in the Soviet Union in general compares favorably with that in the United States. As competition for entrance to universities and colleges is very keen, standards are kept high. University faculties are organized so that each department is quite small and teaching often can be done through informal contact between students and staff. For example, the overall ratio of students to teachers in Soviet colleges was 10.5 to 1 in 1950 compared to about 14 to 1 in the United States. The Soviet ratio was up to 12.6 to 1 in 1954. The ratio varies from school to school, of course, and the Soviets don't always compare so favorably. For example, at Bauman the student-teacher ratio is 11.3 to 1 compared to 5.8 to 1 at MIT and about 2.7 to 1 at CalTech. A weakness of the Soviet system is that training is highly specialized and college graduates therefore often have competence only in narrow specialty fields. Such narrow specialization tends to create a narrowness of outlook and may well reduce the Soviet scientist's chances of producing original scientific research. Furthermore, emphasis throughout schooling is on acquiring knowledge rather than understanding. Many U.S. experts feel that such "spoonfeeding" will also inevitably limit independent inquiry and originality.

As the scientific profession in the Soviet Union is a highly honored and well paid one, the majority of Soviet students wish to prepare themselves for a scientific career. What institute a student attends and what course of study he pursues is largely a matter of state selection. Instead of depending upon individual preference or public appeal to influence the high school graduate's choice of a "major", the Soviets use several effective methods to funnel students into disciplines in accordance with the needs of the State:

(1) They use, of course, propaganda appeals, much as we do, stressing monetary and prestige factors, and in addition point out

## CHART 3

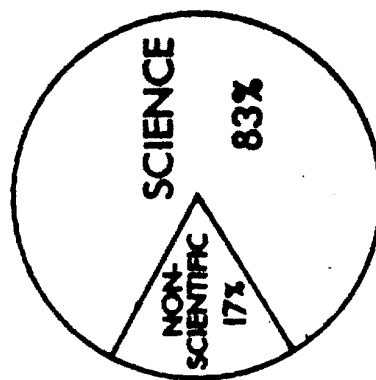
1955 CURRICULUM REQUIREMENTS IN SCIENTIFIC SUBJECTS  
(INCLUDING FOREIGN LANGUAGE) FOR PHYSICS MAJOR  
AT KHARKOV STATE UNIVERSITY

SUBJECTS OF INSTRUCTION	TOTAL NUMBER OF HOURS SPENT ON SUBJECT OVER 4½ YEAR PERIOD
HISTORY OF PHYSICS .....	48
GENERAL CHEMISTRY .....	100
DRAFTING .....	52
HIGHER MATHEMATICS (ANALYSIS, GEOMETRY) .....	584
METHODS OF MATHEMATICAL PHYSICS .....	240
GENERAL PHYSICS (MECHANICS, MOLECULAR PHYSICS, ELECTRICITY, ATOMIC PHYSICS) .....	444
PHYSICS LABORATORY PRACTICE .....	452
THEORETICAL MECHANICS .....	136
THERMODYNAMICS AND STATISTICAL PHYSICS .....	120
ELECTRODYNAMICS (FIELD THEORY AND ELECTRON THEORY) .....	120
QUANTUM MECHANICS .....	120
FUNDAMENTALS OF RADIO ENGINEERING .....	36
SPECIAL SUBJECTS AND SEMINARS AS CHOSEN (ALL ARE SCIENTIFIC) .....	380
LABORATORY IN SPECIAL SUBJECTS .....	424
METHODOLOGY OF TEACHING PHYSICS AND THE TECHNIQUES OF PHYSICAL EXPERIMENTS .....	60
FOREIGN LANGUAGE .....	240

TOTAL NUMBER OF HOURS SPENT ON SCIENTIFIC SUBJECTS - 3556  
OUT OF GRAND TOTAL OF - 4290

CHART 39  
1955 CURRICULUM REQUIREMENTS IN NON-  
SCIENTIFIC SUBJECTS FOR PHYSICS MAJOR  
AT KHARKOV STATE UNIVERSITY

SUBJECTS OF INSTRUCTION	TOTAL NUMBER OF HOURS SPENT ON SUBJECT OVER 4 1/2 YEAR PERIOD
FOUNDATIONS OF MARXISM-LENINISM.....	250
POLITICAL ECONOMY.....	140
PHILOSOPHY.....	140
PHYSICAL EDUCATION AND SPORTS.....	136
PEDAGOGY.....	68
	TOTAL HOURS 734





## CHART 4

1955 CURRICULUM REQUIREMENTS IN SCIENTIFIC SUBJECTS  
(INCLUDING FOREIGN LANGUAGE) FOR MECHANICAL ENGINEERING  
STUDENTS MAJORING IN "MACHINE CONSTRUCTION, METAL CUTTING  
MACHINE TOOLS AND TOOLS" AT BAUMAN HIGHER TECHNICAL SCHOOL.

NUMBER OF HOURS SPENT ON  
SUBJECT OVER 5 YEAR PERIOD

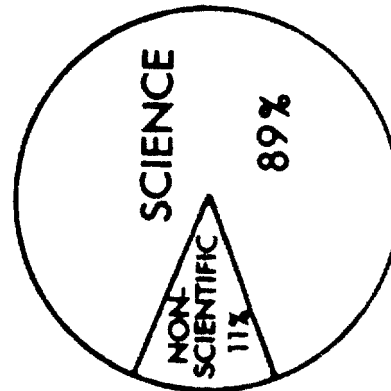
## SUBJECTS OF INSTRUCTION

HIGHER MATHEMATICS .....	308
PHYSICS .....	245
GENERAL CHEMISTRY .....	120
DESCRIPTIVE GEOMETRY .....	90
MACHINE CONSTRUCTION DRAFTING AND DRAWING .....	188
THEORETICAL MECHANICS .....	214
STRENGTH OF MATERIALS .....	232
THEORY OF MECHANISMS AND MACHINES .....	198
MACHINE DETAILS .....	215
GENERAL ELECTRICAL TECHNOLOGY AND MEASUREMENTS OF NON ELECTRIC MAGNITUDES .....	190
HYDRAULICS AND HYDRAULIC MACHINERY .....	84
GENERAL HEAT ENGINEERING .....	78
PHYSICAL METALLURGY AND HEAT-TREATMENT OF METALS .....	96
TECHNOLOGY OF METALS (METALLURGY AND HOT FABRICATION) .....	118
SHOP TRAINING .....	204
INTERCHANGEABILITY AND TECHNICAL MEASUREMENTS .....	68
MATERIAL HANDLING MACHINERY AND MECHANISMS .....	116
METAL WORKING MACHINE TOOLS AND AUTOMATICS .....	337
HYDRAULIC EQUIPMENT IN MACHINE TOOLS .....	56
ELECTRICAL EQUIPMENT IN MACHINE TOOLS .....	65
METAL CUTTING .....	80
METAL CUTTING TOOLS .....	221
MACHINE CONSTRUCTION TECHNOLOGY .....	208
CONSTRUCTION OF MECHANICAL EQUIPMENT .....	39
PLANNING OF MACHINE BUILDING SHOPS AND ELEMENTS OF STRUCTURAL ENGINEERING .....	65
THERMAL TREATMENT OF MACHINE DETAILS .....	39
AUTOMATION OF INDUSTRIAL PROCESSES .....	65
INDUSTRIAL ECONOMICS AND ORGANIZATION AND PLANNING OF ENTERPRISES .....	91
HISTORY OF ENGINEERING .....	39
SAFETY ENGINEERING AND FIRE PROTECTION ENGINEERING .....	39
FOREIGN LANGUAGE .....	134

TOTAL NUMBER OF HOURS SPENT ON SCIENTIFIC SUBJECTS - 4322  
OUT OF GRAND TOTAL OF - 4848

**CHART 4a**  
**1955 CURRICULUM REQUIREMENTS IN NON-SCIENTIFIC SUBJECTS FOR MECHANICAL ENGINEERING STUDENTS MAJORING IN "MACHINE CONSTRUCTION METAL CUTTING MACHINE TOOLS AND TOOLS" AT BAUMAN HIGHER TECHNICAL SCHOOL.**

SUBJECTS OF INSTRUCTION	TOTAL NUMBER OF HOURS SPENT ON SUBJECT OVER 5 YEAR PERIOD
FOUNDATIONS OF MARXISM-LENINISM	252
POLITICAL ECONOMY	140
PHYSICAL EDUCATION AND SPORTS	134
	<b>TOTAL HOURS 526</b>



that it is the Soviet student's duty to prepare himself for usefulness in achieving socialist supremacy.

(2) Another very potent method of channeling students into desired fields is the threat of military draft. Students who enroll at particular specialized schools or in certain courses are given total draft exemptions or continuing deferments. For example, during the war a law was passed listing some 85 technical colleges whose students would be totally exempt from military draft as long as they successfully continued their studies in engineering and technical fields--fields in which there were definite needs. The law still remains in force today.

(3) Also, each college and university has a quota system. There are always more applicants than vacancies in scientific and technical fields. When shortages of specialists are anticipated, quotas are raised thereby admitting larger numbers of people.

(4) Finally, scholarships and stipends serve to channel students into desired study areas. Scientific or engineering students receive more rubles per month than do their fellows who study, say, history. As State needs change, of course, so also does the amount of stipend in a given subject field.

A quarter of a million students each year successfully complete their studies and graduate from college in the Soviet Union. Here again, the State steps in--graduates are assigned to jobs in the economy. Though some graduates may occasionally use outside influence or political "pull" to get desired assignments, most students consider it just that they work wherever the State assigns them. After all, they reason, the State paid for their education and training and therefore they are obligated to repay the State by their work. The best students usually want to go into research and do so. Once assigned a graduate has little opportunity for transfer. The engineer or scientist must remain in his assigned place for at least three years. Hence it is that 80% of Soviet science graduates are actually employed in scientific fields while only 60% of our science graduates work in their fields.

Graduates and researchers who show exceptional promise are selected for advanced training. After studying for three years and preparing a dissertation, they are awarded a "Candidate" degree, roughly comparable to our Ph.D. The Soviets already have more science "Candidates" than we have Ph.D.'s in science. Chart 5, Higher Degrees in Science Awarded Annually, shows the numbers of Soviet "Candidate" and United States Ph.D. degrees awarded in science each year from 1935 to mid-1954. As early as 1935 they awarded 18,000 "Candidate" degrees while we granted only about 15,000 Ph.D. degrees that year. As you can see, they have continuously awarded more higher degrees than we have, except during

the war years. In June of 1951 they granted 8,100 "Candidate" degrees compared to only 5,000 Ph.D.'s granted in this country. All in all, by mid-1955 there was a total of 55,000 Ph.D.'s in science in this country. 70,000 Soviets held "Candidate" degrees in science.

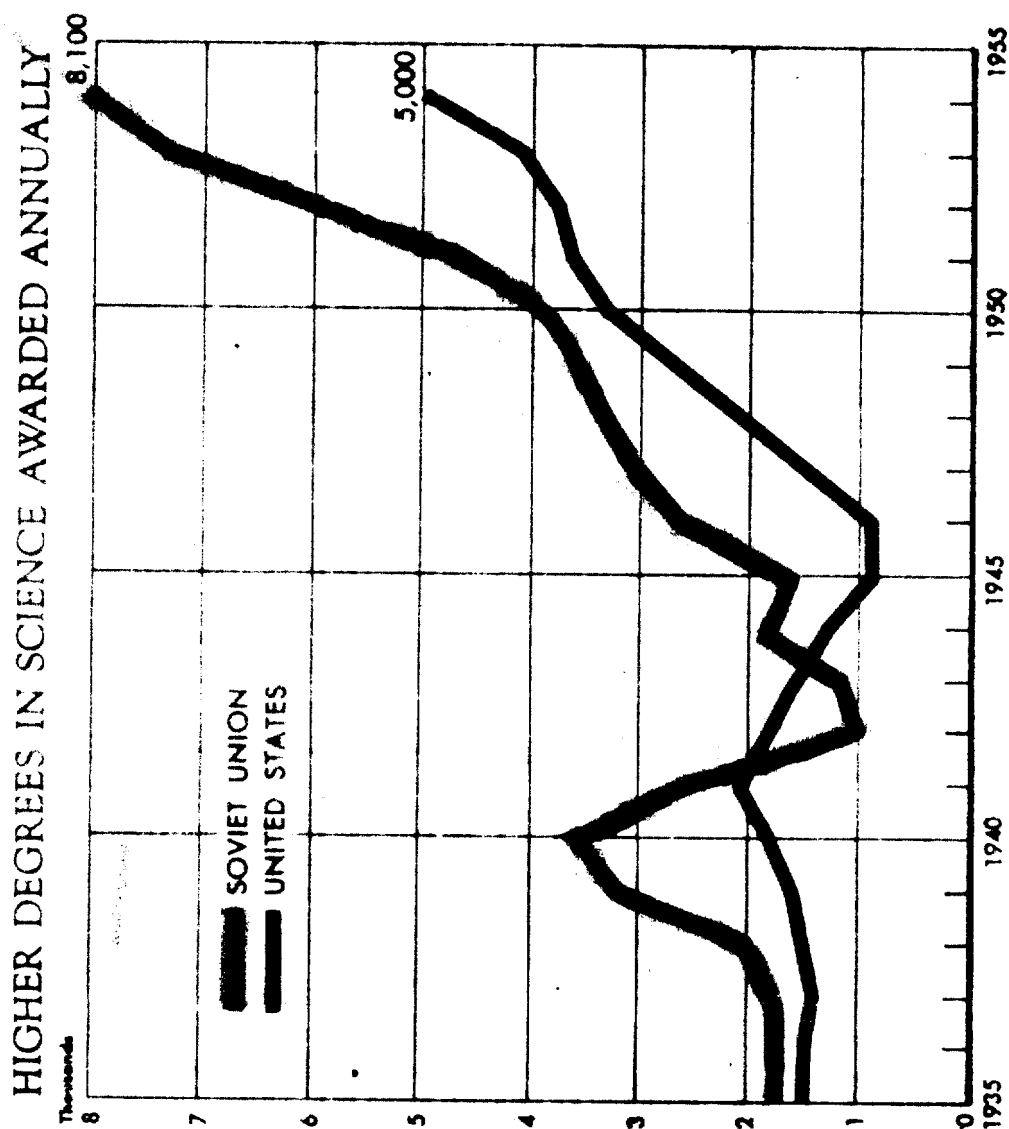
The government has ultimate power to assign personnel where they are most needed; however, such assignment decisions are not always infallible. Evils of bureaucracy plague the Soviets, too. There is often wasted talent and duplication of effort. But centralized power does insure that higher priority projects are allocated adequate manpower for the jobs. For this reason scientific achievements vary from field to field. In areas important to national power and military strength the Soviets excel. For example, their work in combustion phenomena and chemical kinetics is probably the finest in the world, and they are highly competent in low temperature physics research.

They have recently announced the existence of a number of high speed electronic digital computers. The largest of these, the BESM, is comparable to some of the better high speed computers in the United States and U.K., although not quite so good as a recently completed U.S. computer. Nesmeyanov, President of the USSR Academy of Sciences, has announced that high speed computer research is one of a number of areas of fundamental importance in which the Soviets will concentrate their efforts as, he stated, research in this field is likely to lead to a scientific breakthrough.

In the field of nuclear research, they have achieved significant advances, and have now added high quality competence in developing particle accelerators. At the Atoms for Peace Conference in Geneva, the Soviets announced that by 1956 they will complete a 10 BEV proton synchrotron which will be the largest in the world. United States and European laboratories are designing and constructing accelerators in the 30 BEV range due for completion in 1960 or 1961. But the Russians are planning a still larger accelerator up to 50 BEV. On the other hand, Soviet agricultural research, in general, has been poor, and medical research seems unable to do more than just catch up with the West.

In order to exploit foreign scientific advances, the Soviets have an extensive information gathering program and are rapidly working to perfect a comprehensive system for disseminating these data. Their abstracting service is a "State matter" and is accomplished primarily by ministerial offices and the USSR Academy of Sciences. The Academy's Institute of Scientific Information gives very thorough coverage of the world's scientific literature. In 1956, the Institute will sponsor publication of 12 series of abstract journals. It is estimated that one year's production of the series will compare in size to about 35 volumes of the Soviet Encyclopedia (slightly larger than 35 volumes of the Britannica). Not only is the abstracting service large, but it is

CHART 5



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quick. We know of instances in which abstracts of United States articles have appeared in Soviet abstract journals before they appeared in United States abstract journals. Perfection of this dissemination program will undoubtedly save time and expense in the Soviet's research and development effort.

To sum up—though the Soviets now have only 2/3ds the number of scientists and engineers in research and teaching that the United States has, they are graduating more in science each year and may soon have a decided numerical advantage. Because Soviet engineering training is highly specialized, the quality of Soviet engineers may be inferior to United States engineers. But Soviet scientific achievements show that the overall quality of Soviet scientists compares favorably with that of the United States. Soviet scientists can do anything we can do, but not everything we can do. How soon they'll be able to do everything will depend in part on their rapidly growing pool of scientific-technical manpower resources.